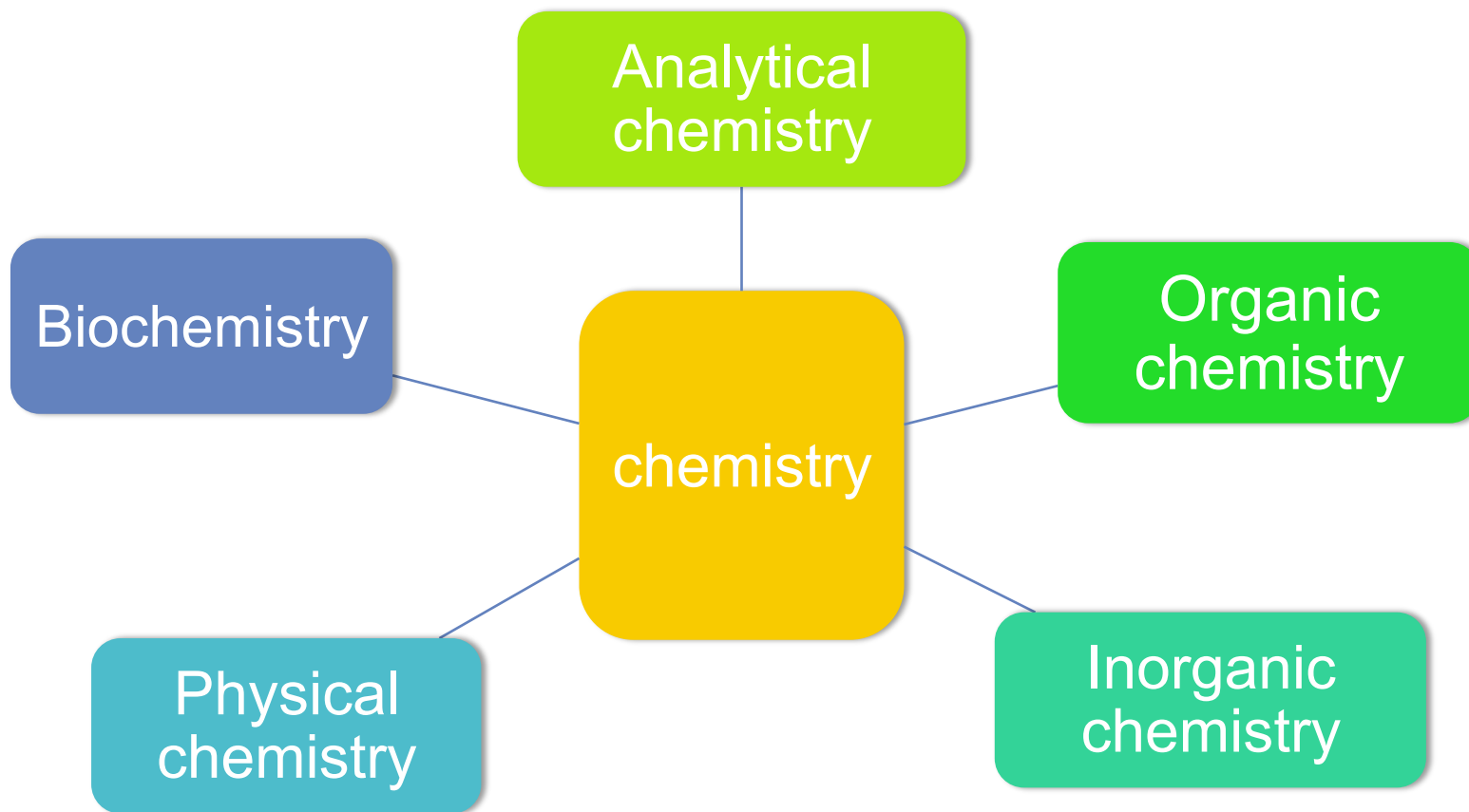


# **INTRODUCTION TO CHEMISTRY**

# WHAT IS CHEMISTRY?

- the branch of science that deals with the identification of the substances of which matter is composed;
- the investigation of their properties and the ways in which they interact, combine, and change;
- and the use of these processes to form new substances

# BRANCHES OF CHEMISTRY



# BRANCHES OF CHEMISTRY

- **Analytical chemistry:**
  - the study of the chemistry of matter and the development of tools used to measure properties of matter.
  - Examples:
    - How much caffeine is really in a cup of coffee?
    - Are there drugs found in athlete's urine samples?
- **Organic chemistry:**
  - the study of carbon and its compounds; the study of the chemistry of life.
  - Examples:
    - the process of photosynthesis
    - formulating a conditioner that keeps hair softer
    - developing a better drug for headaches

# BRANCHES OF CHEMISTRY

- **Inorganic chemistry:**

- the study of compounds not-covered by organic chemistry; the study of inorganic compounds or compounds which do not contain a C-H bond.
- Examples:
  - crystal structures, minerals, metals, catalysts, and most elements on the periodic table
  - investigating how gold is formed in the earth
  - Carbon and other elements (e.g. carbon dioxide)

- **Physical chemistry:**

- the branch of chemistry concerned with the application of the techniques and theories of physics to the study of chemical systems; the study of how chemical structure impacts physical properties of a substance
- Example:
  - Heat/ energy/ rate of reactions

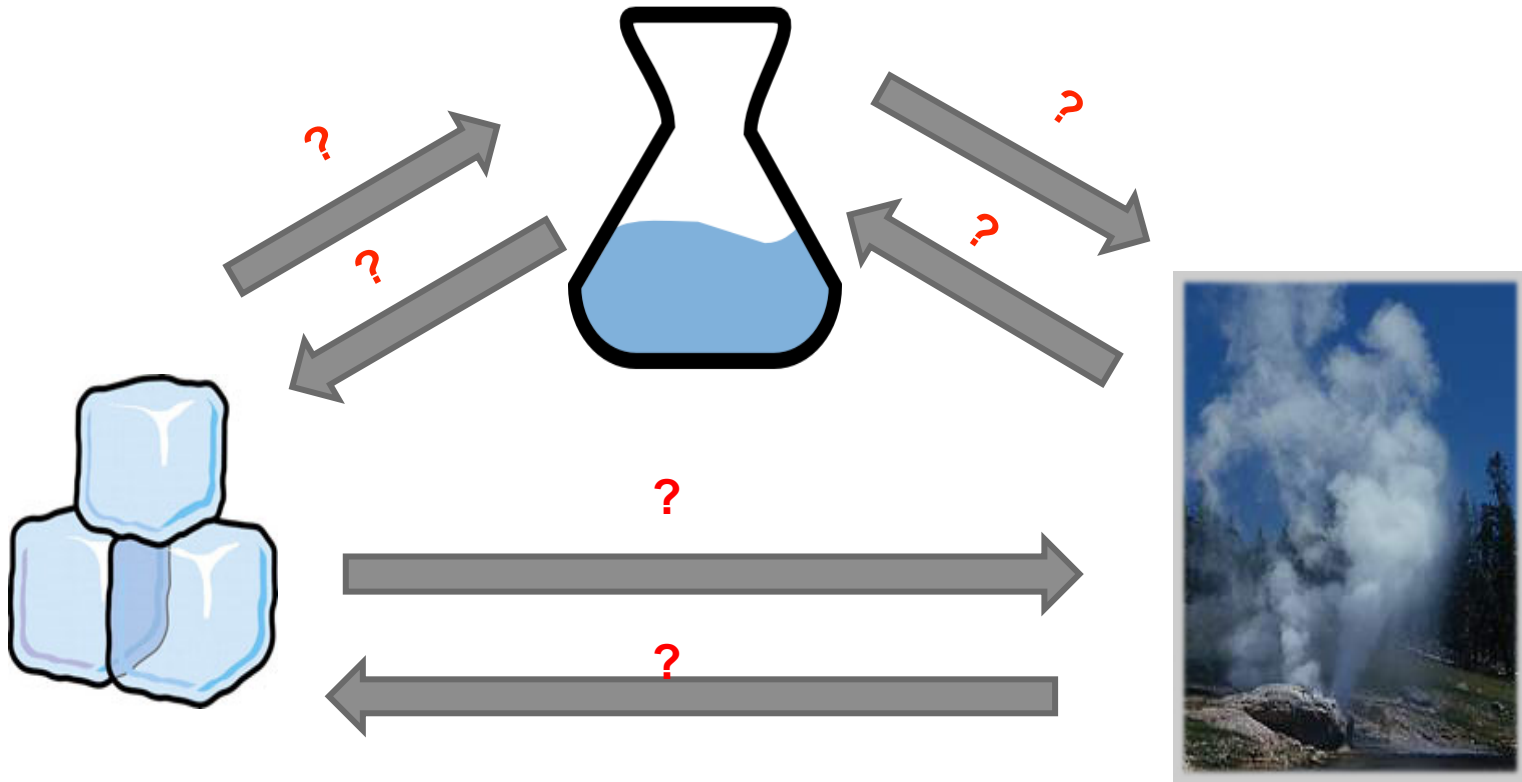
# BRANCHES OF CHEMISTRY

- **Biochemistry**
  - the study of chemical processes that occur inside of living organisms.
  - Examples:
    - cancer and stem cell biology
    - infectious disease

# **PHYSICAL CHANGES**

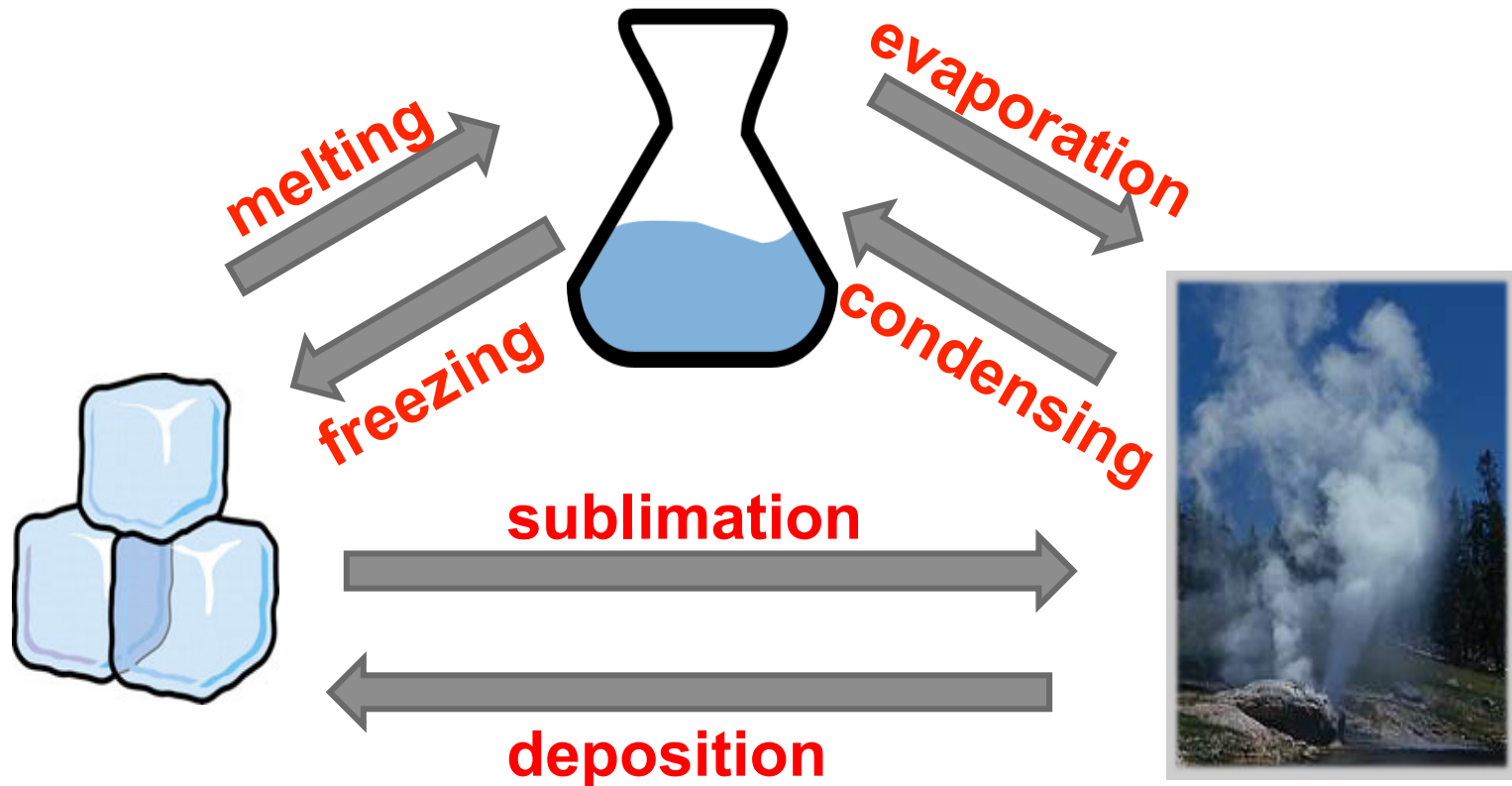
- **A change of matter from one state to another**
- **Physical changes do not change a substance's identity.**

# CHANGES OF STATES





# CHANGES OF STATES



# CHEMICAL CHANGE

- Chemical changes happen everywhere.
- Examples of chemical changes include:
  - burning
  - rusting
  - digesting
  - decomposing
- Chemical change: a change that occurs when a substance changes composition by forming one or more new substances

# CHEMICAL CHANGE

## Examples of Chemical Changes



John Morrison/Morrison Photography

**A** Soured milk smells bad because bacteria have formed new substances in the milk.



BSIP/Phototake

**B** Effervescent tablets bubble when the citric acid and baking soda in them react with water to produce  $\text{CO}_2$ .



SuperStock

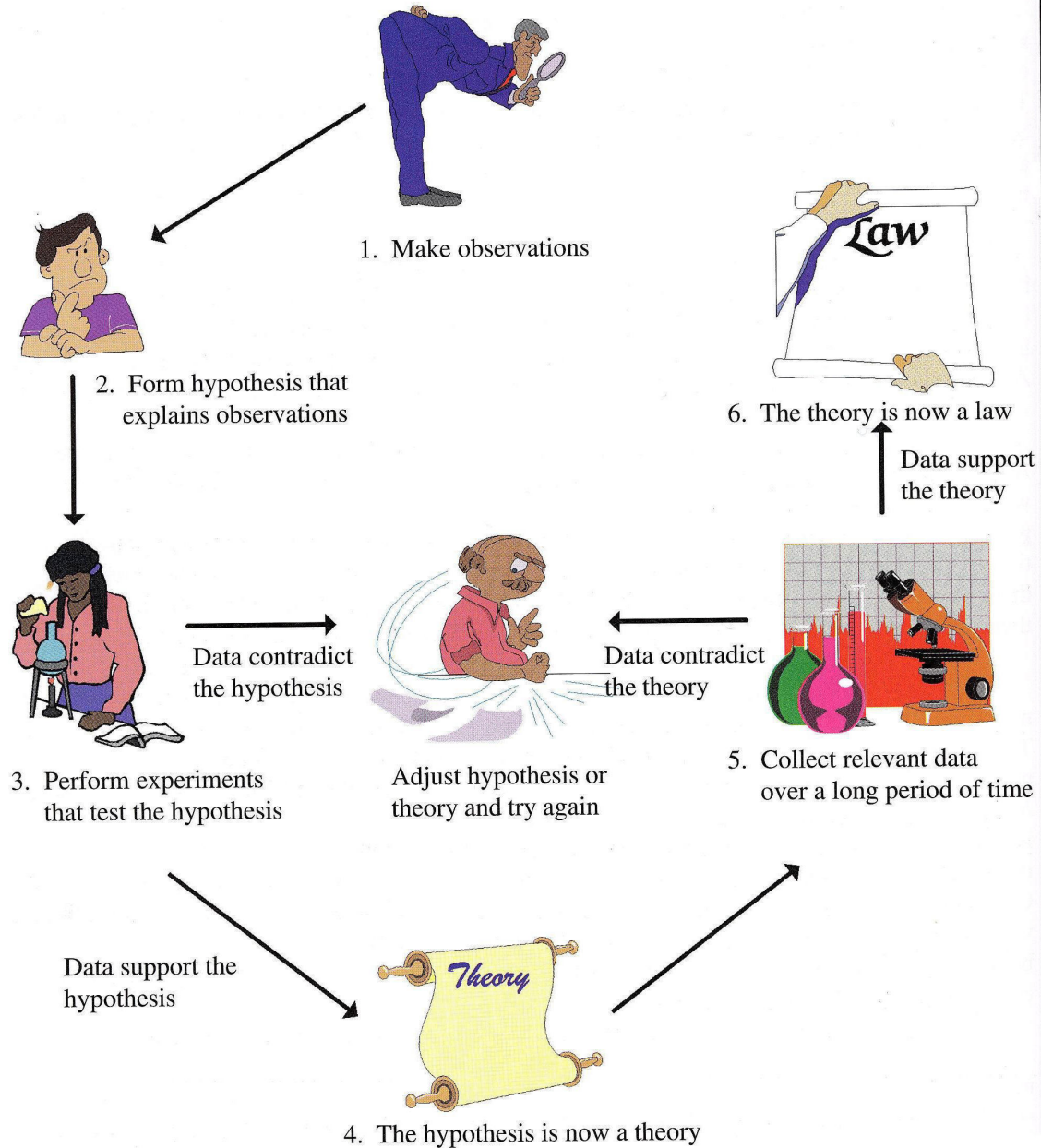
**C** The Statue of Liberty is made of shiny, orange-brown copper. But the metal's interaction with carbon dioxide and water has formed a new substance, copper carbonate.

# SCIENTIFIC METHOD

What can you observe in this picture?



**FIGURE 2.2**  
The Scientific Method



# SCIENTIFIC METHOD

- Scientist use existing theories to explain ideas
- You need to observe things carefully to see if a variable plays a role in the investigation.
- They formulate a hypothesis and collect data
- Scientists need to make sure their data is **reliable** and **valid**
- Reliable by repeating and collecting data so you can trust your data
- Valid if it supports what you are trying to prove

# EXPERIMENT TIME

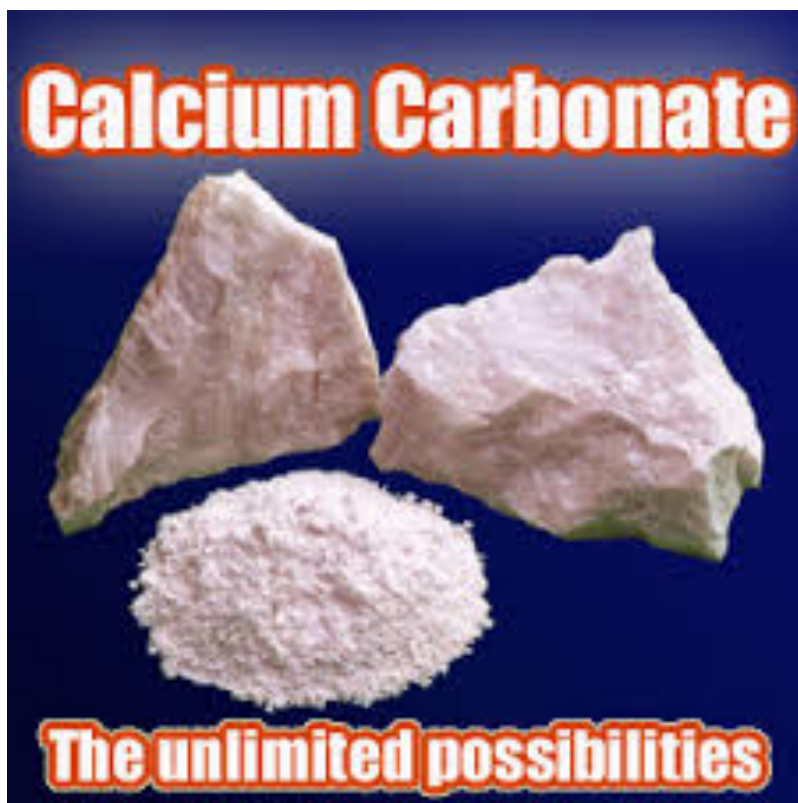
The reaction of calcium carbonate and hydrochloric acid





# EXPERIMENT TIME

I want to see more bubbles, what can I add?





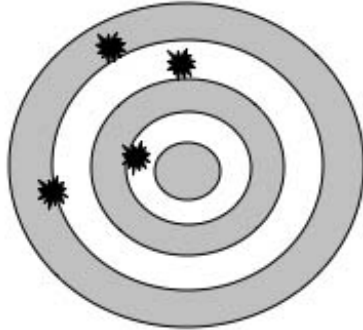
# **PRECISION VS ACCURACY**

- **What do you think is the difference between these two terms?**
- **Can a measurement be precise but not accurate?**

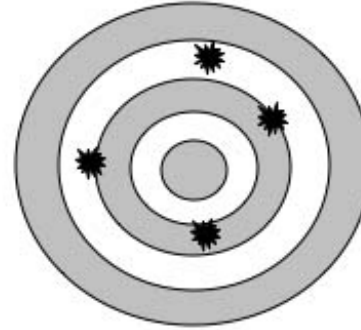
# **PRECISION VS ACCURACY**

- **Accuracy is an indication of how close a measurement is to the accepted (true) value**
- **Precision is an indication of the agreement among a number of measurements made in the same way.**
- **Confusing??? Lets look at the following diagram**

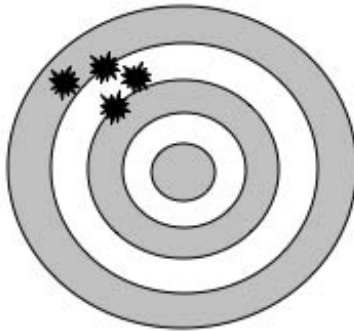
# PRECISION VS ACCURACY



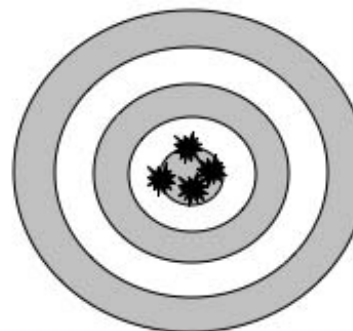
Not Accurate  
Not Precise



Accurate  
Not Precise



Not Accurate  
Precise



Accurate  
Precise

# ERRORS

When making measurements, there are 2 main types of error:

- Random errors
- Systematic errors.

Let's look at some examples . . .

# **RANDOM ERRORS**

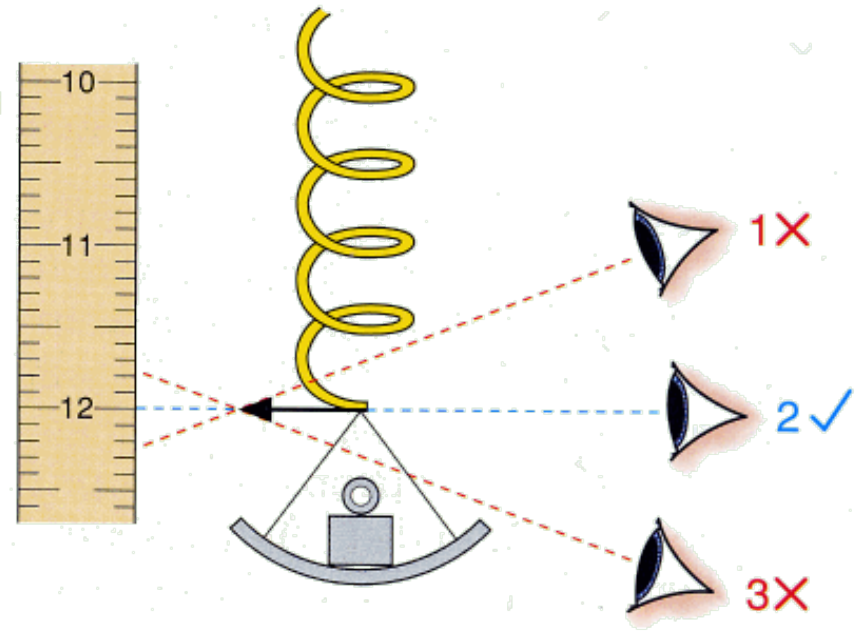
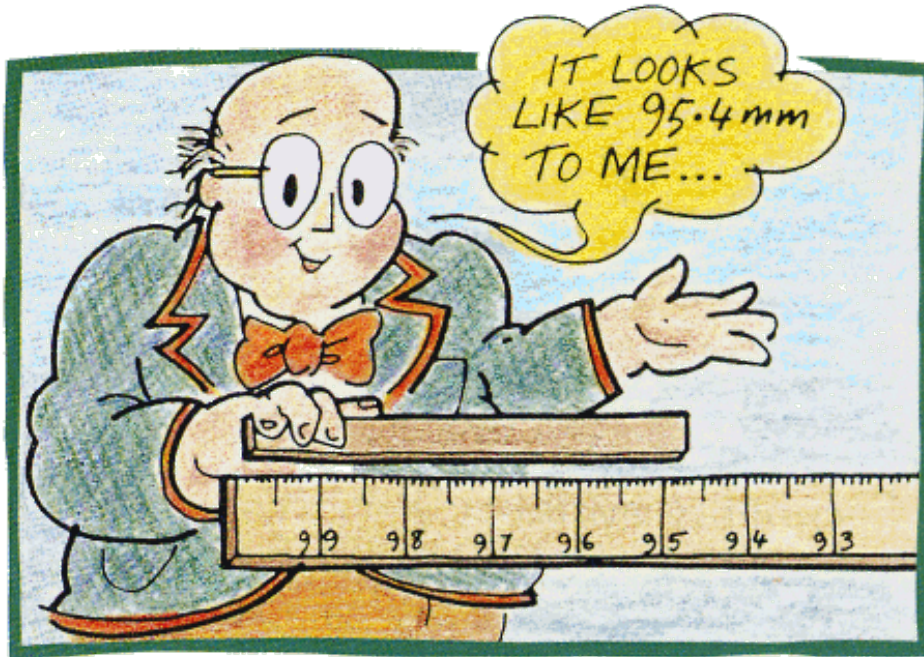
These may be due to

- human error
- faulty technique
- faulty equipment

# RANDOM ERRORS

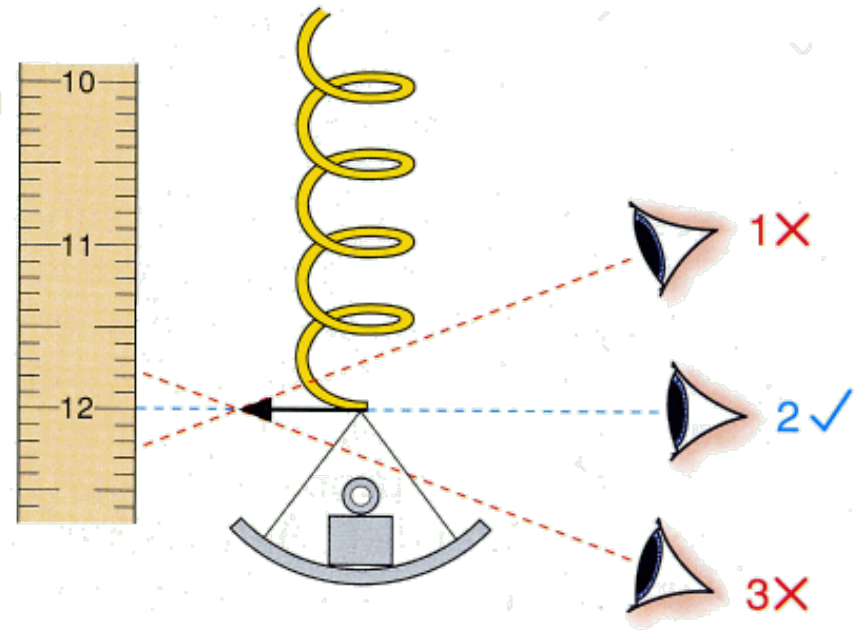
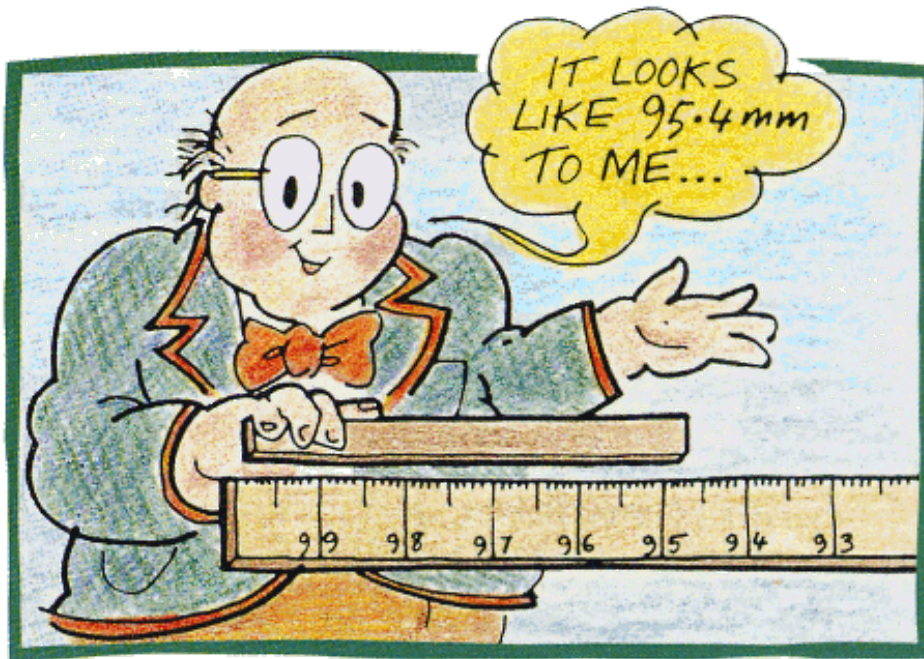
Examples:

- Parallax error (eye-level error)
- Human error



# RANDOM ERRORS

To reduce the error, take a lot of readings, and then **calculate the average (mean)**.



# SYSTEMATIC ERRORS

These errors cause readings to be shifted one way (or the other) from the true reading.

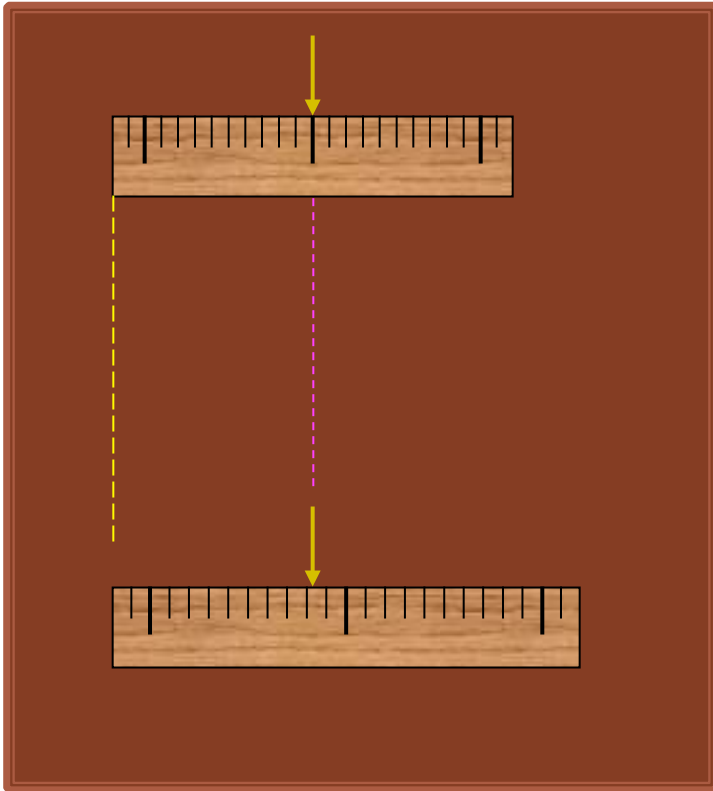


# SYSTEMATIC ERRORS

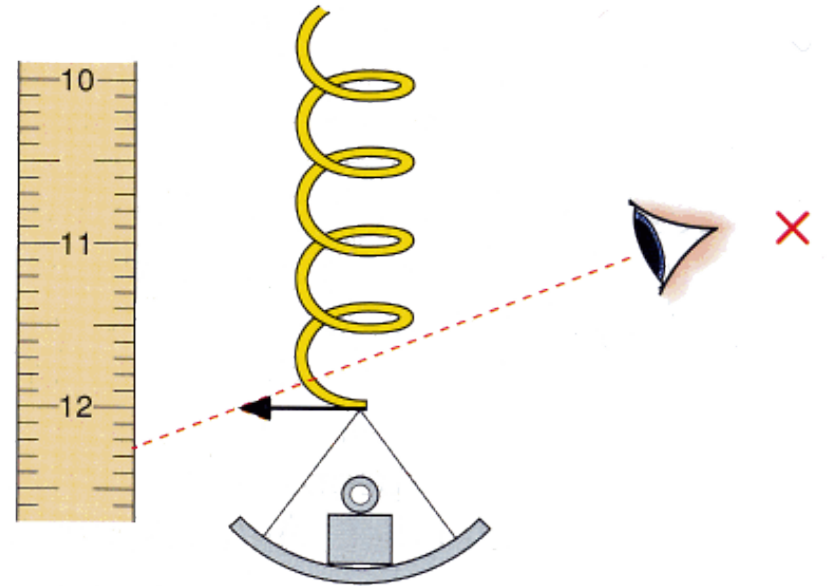
Examples:

- Calibration error
- Repeated parallax error
- Zero error

# SYSTEMATIC ERRORS

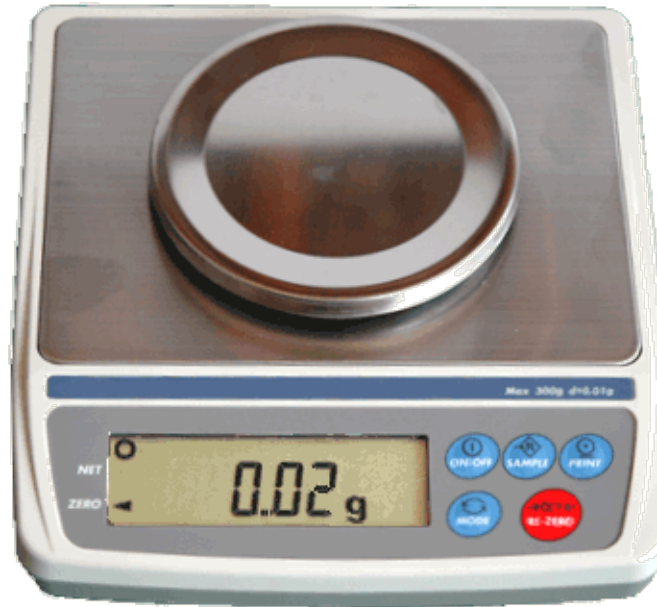


ruler is wrongly calibrated,  
or if it expands, then all  
the readings will be too  
low (or all too high)



with your eye always  
too high, all your  
readings will be too  
high

# SYSTEMATIC ERRORS

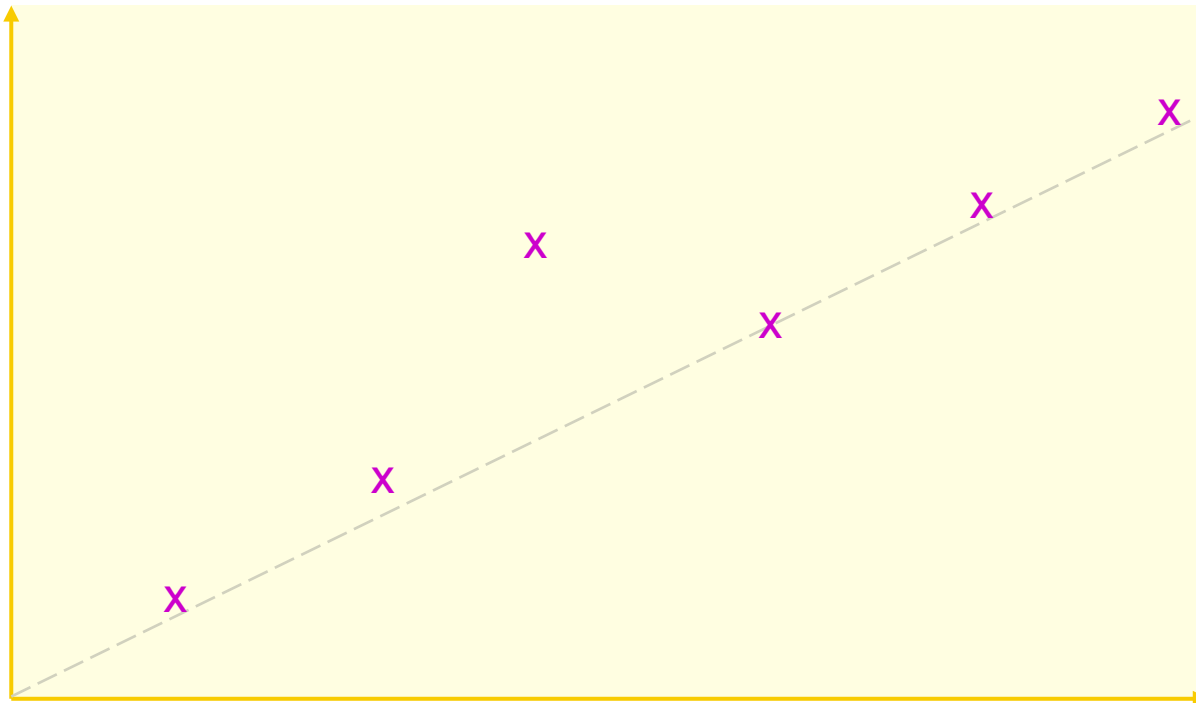


There is nothing on it, but it is not reading zero.

What effect do you think this will have on all the readings?

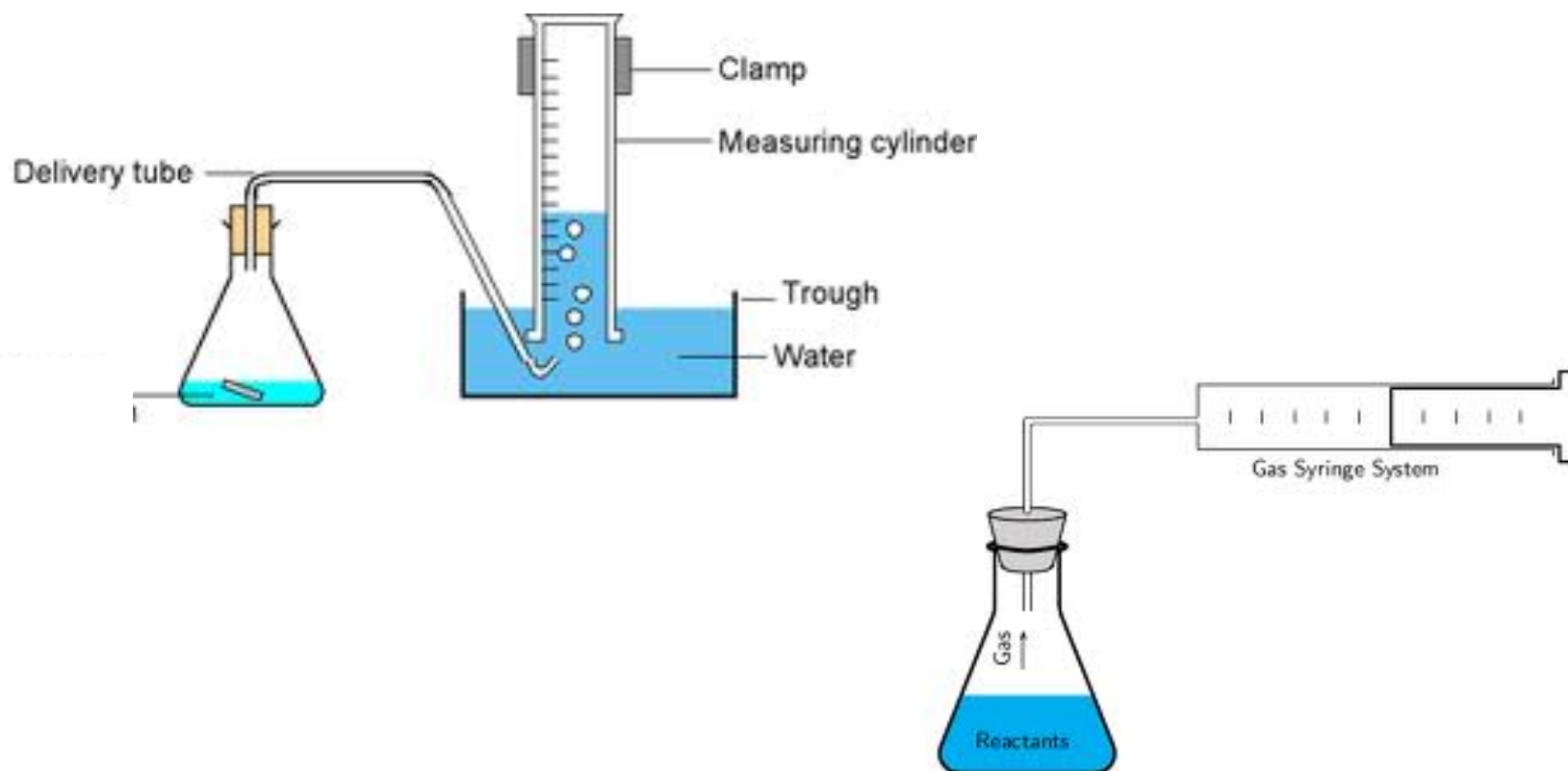
# ANOMALOUS RESULT

- Which result do you think may be anomalous (inconsistent)?
- Is this caused by a random or systematic error?



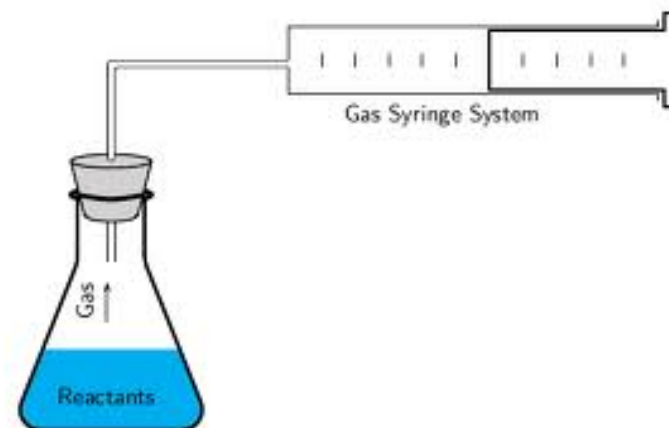
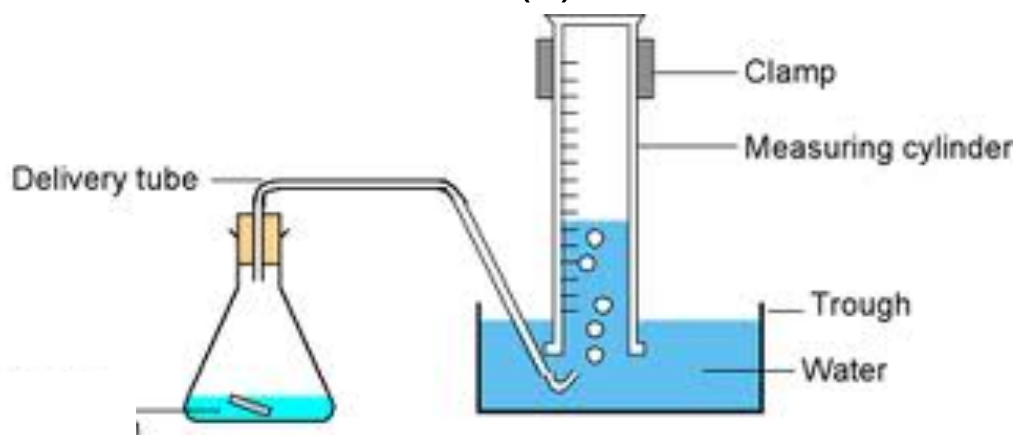
# DESIGNING AN EXPERIMENT

- You are observing the reaction of calcium carbonate and hydrochloric acid and you want to change the concentration of the hydrochloric acid and collect the gas (carbon dioxide) that comes out



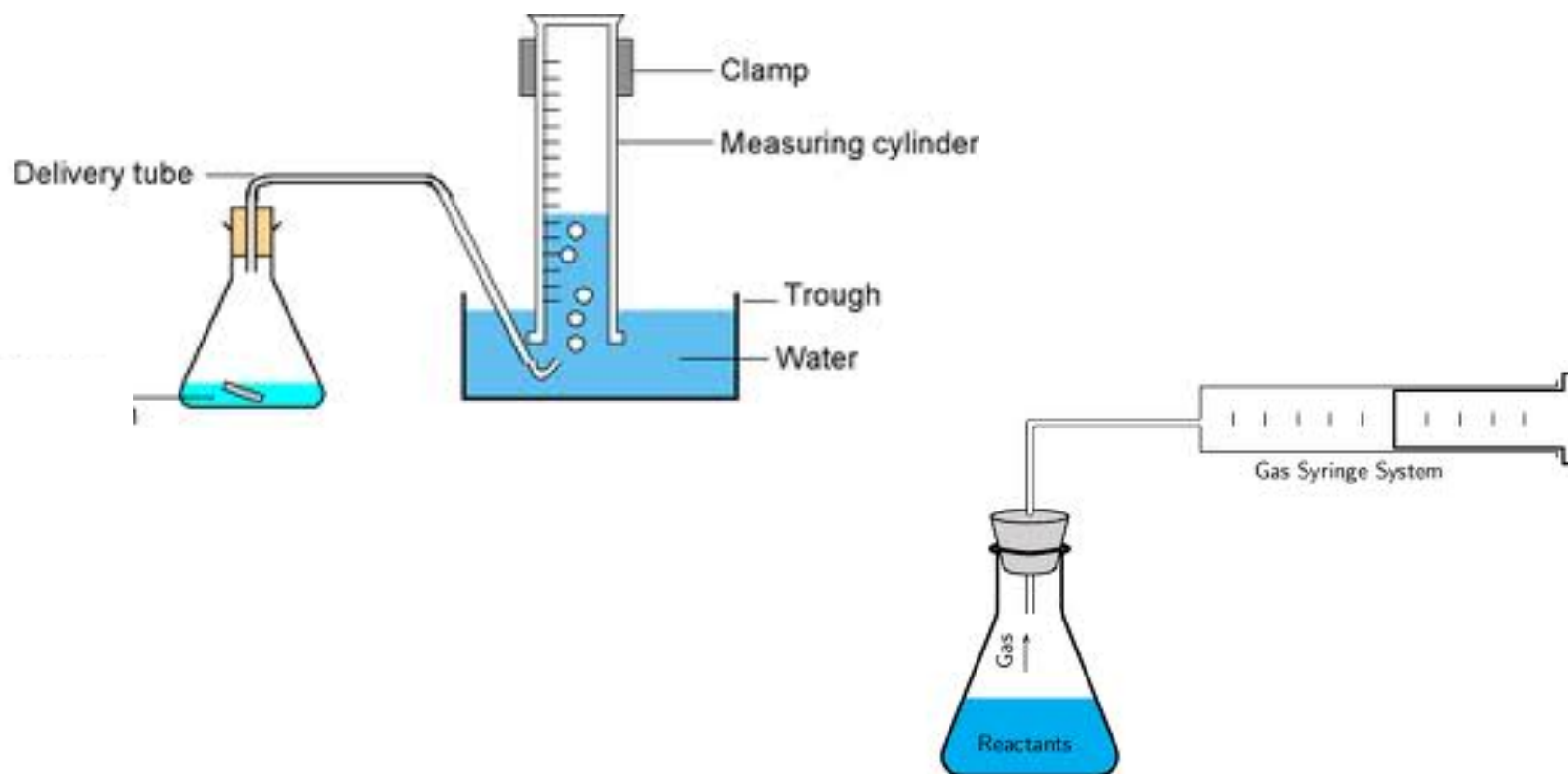
# DESIGNING AN EXPERIMENT

- What is the
  - Independent variable:
  - Dependent variable:
  - Controlled variable(s):



# DESIGNING AN EXPERIMENT

- How do we make this test fair?



# TYPES OF VARIABLES

- **Categoric variables: variables that we can describe**
  - E.g: type of acid “hydrochloric acid”
- **Ordered variables: categoric variables we can put in order**
  - E.g: surface area of calcium carbonate (small/medium/large chips)
- **Continous variables: variables we describe with number**
  - E.g: conteration of acid (1M, 2M, 3M)
- **Discrete variables: variables with only whole numbers**
  - E.g: number of marble chips



# **PRESENTING YOUR DATA**

- **You now want to examine the affect of temperature on the rate of carbon dioxide production. You will perform the experiment three times for different temperatures.**
- **identify your variables and their type**
- **Design a table to help you collect data.**

# PRESENTING YOUR DATA

- You now want to examine the affect of temperature on the rate of carbon dioxide production. You will perform the experiment three times for different temperatures. Design a table to help you collect data.

Table I: Time to collect carbon dioxide with different temperature

	Time to collect 20 cm <sup>3</sup> of gas (s)			
Temperature (°C)	Test 1	Test 2	Test 3	Average

# PRESENTING YOUR DATA

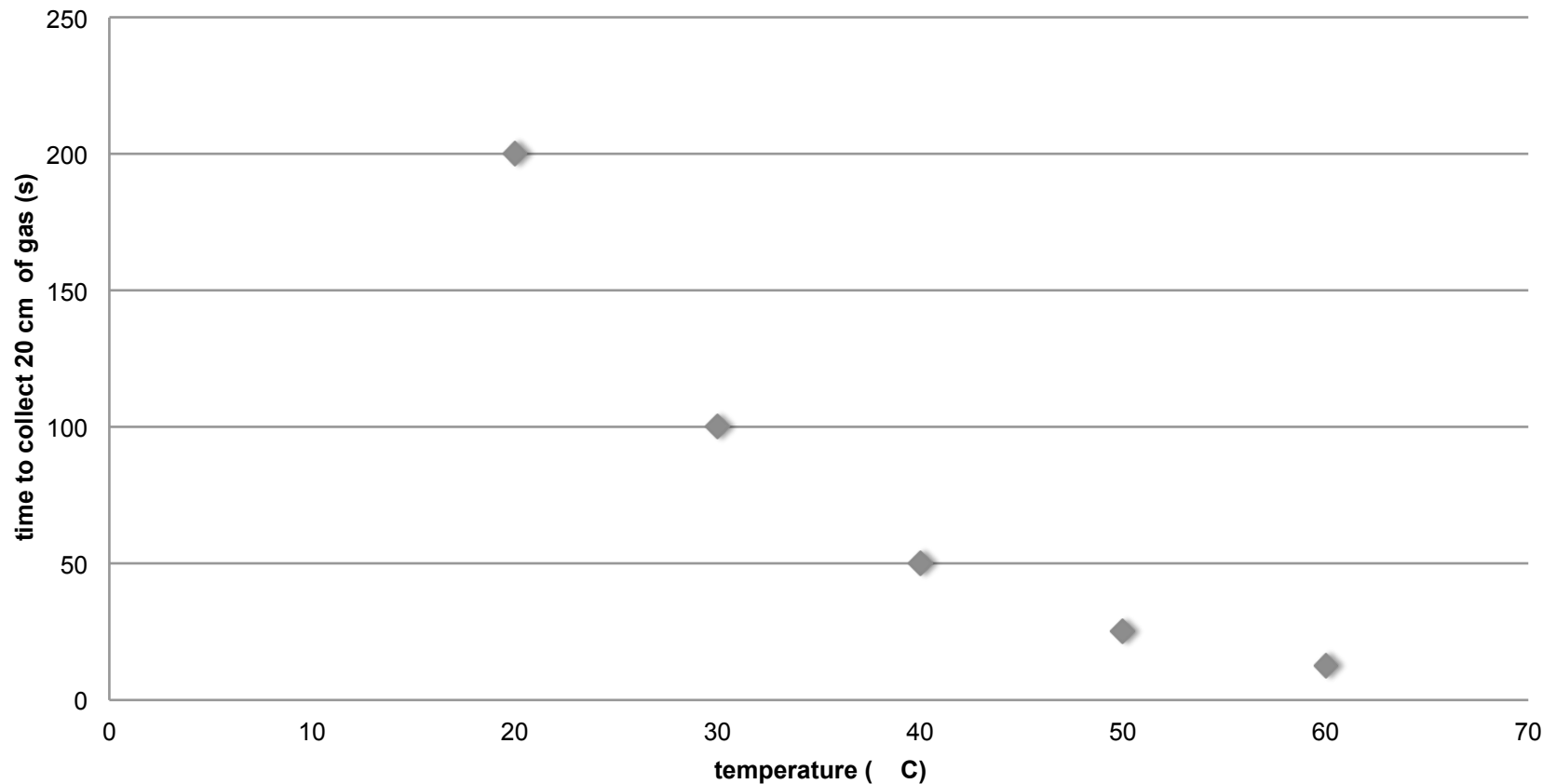
- Calculate the average and graph your results

	Time to collect 20 cm <sup>3</sup> of gas (s)			
Temperature (°C)	Test 1	Test 2	Test 3	Average
20	205	195	200	
30	93	105	102	
40	40	42	38	
50	18	30	27	
60	10	16	12	

# PRESENTING YOUR DATA

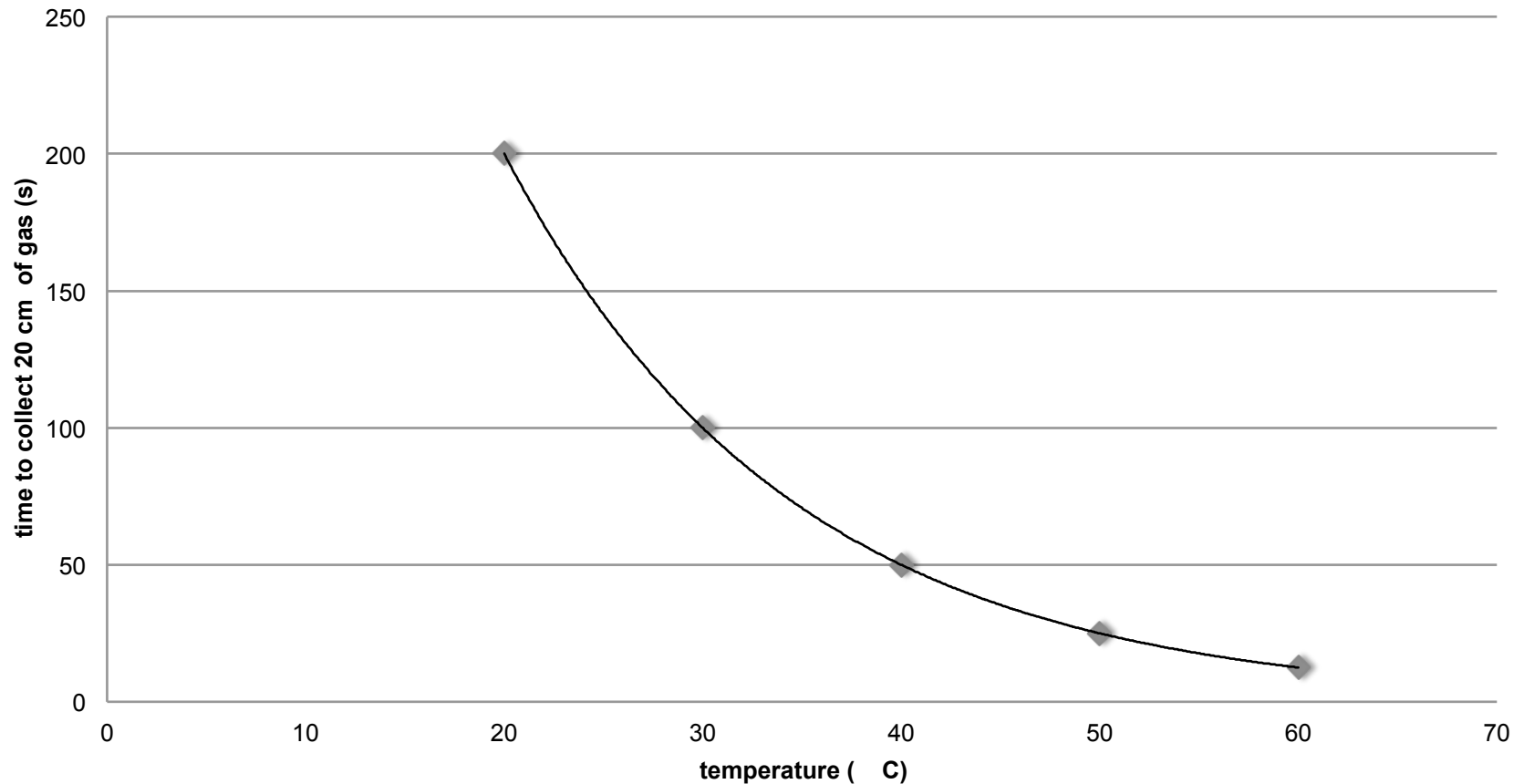
- Calculate the average and graph your results

time to collect 20 cm of gas VS temperature



# PRESENTING YOUR DATA

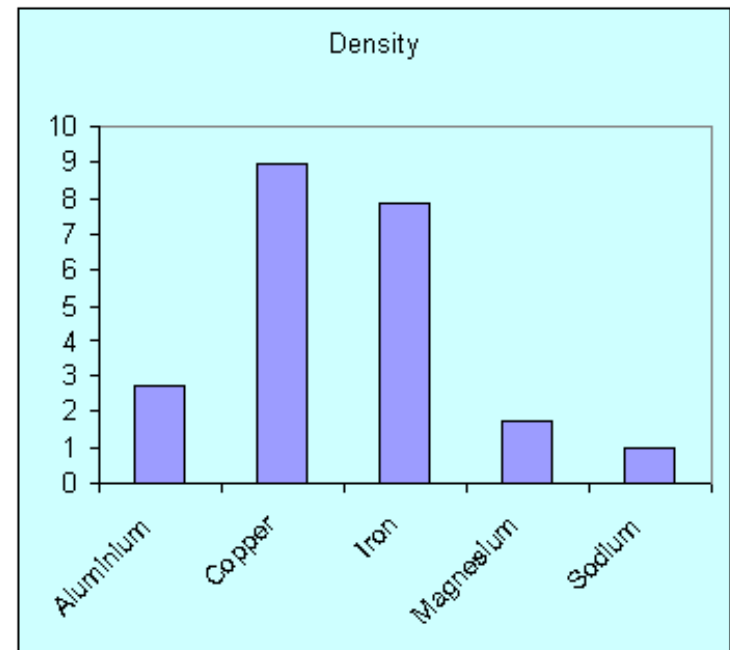
- Calculate the average and graph your results  
time to collect 20 cm of gas VS temperature



# REPRESENTING YOUR DATA

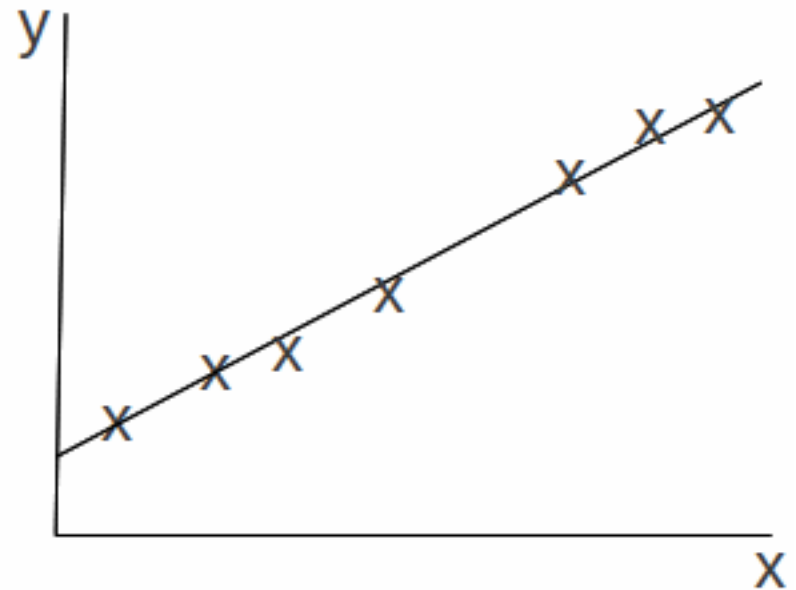
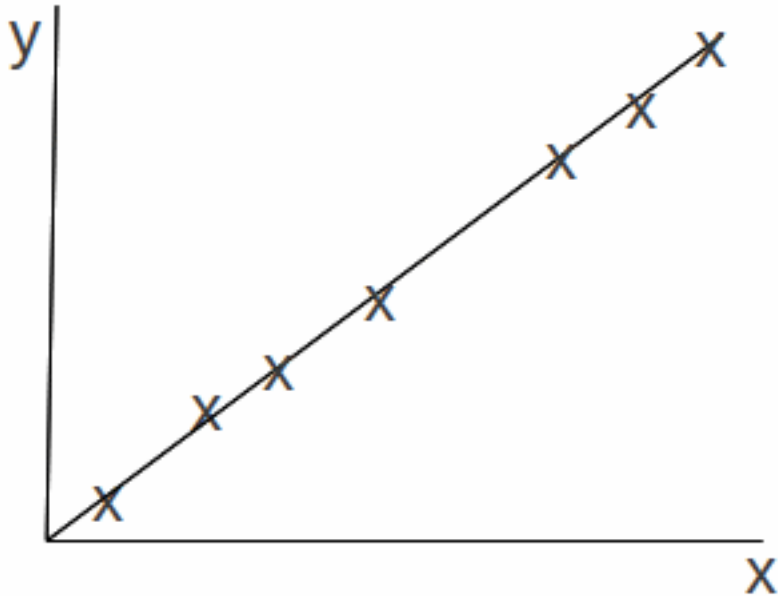
Represent your data with a:

- Line graph: continuous data
- Bar graph: categorical data



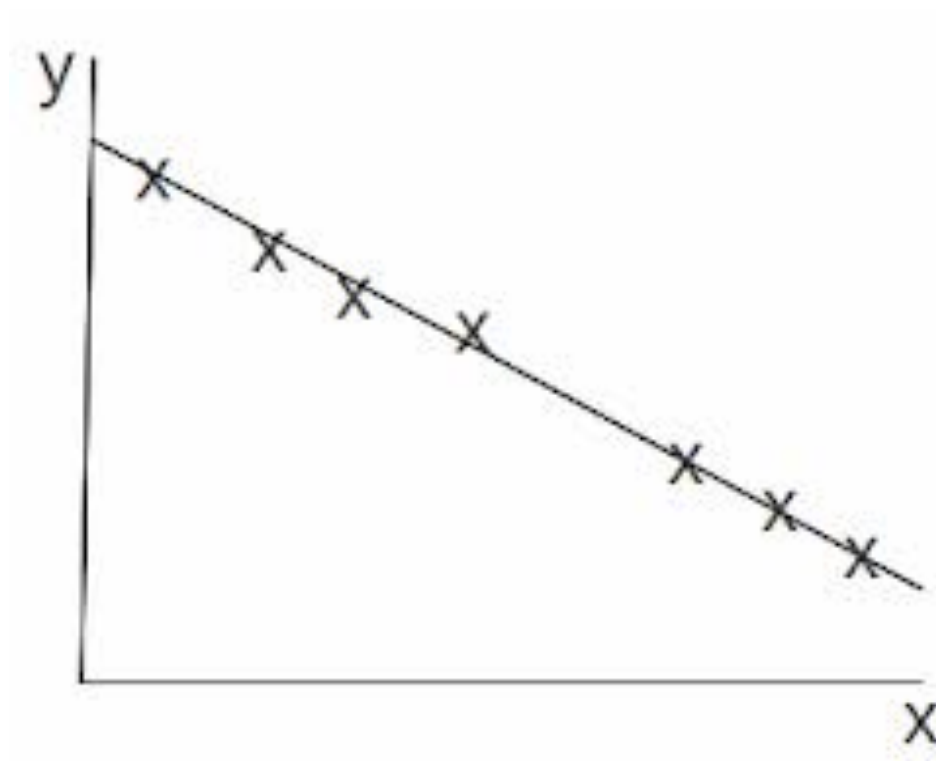
# SPOTTING A PATTERN

Line graph:



# SPOTTING A PATTERN

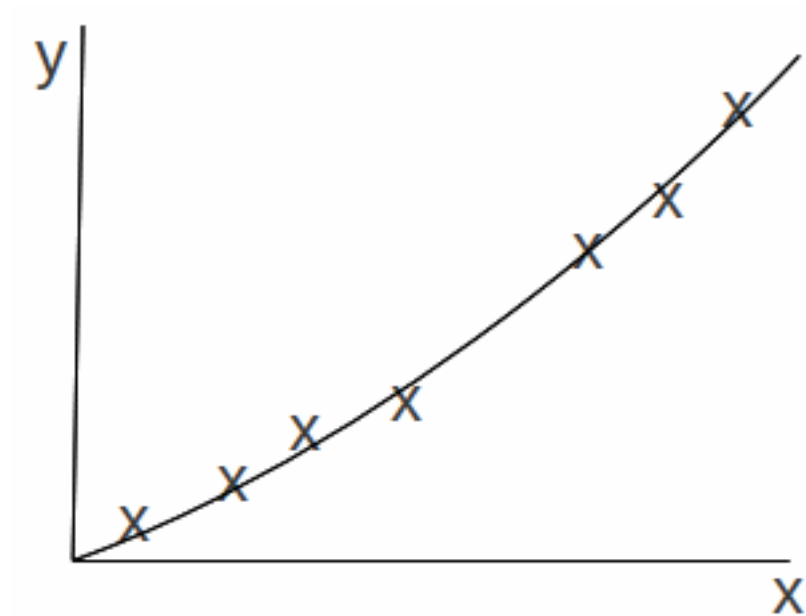
Line graph:





# SPOTTING A PATTERN

curve graph:



# **SPOTTING A PATTERN**

- **Relationships might be only valid for a certain range of value.**
- **This will be a limitation**



